Spectrometric Monitoring Method for Concentration of Hydrogen Peroxide in a Chemical Etching Solution of GaAs

Kazuhiro Shigyo, Sonoko Umemura, and Masaru Kinugawa
Mitsubishi Electric Corporation,
Advanced Technology R&D Center
Tsukaguchi Honmachi 8-1-1,
Amagasaki, Hyogo, 661-8661, Japan

Introduction

Several etching techniques are employed for the fabrication of laser diodes and microwave devices. Wet chemical etching is preferable because it causes less damage to the etched surface, processes compositional selectiveness, and forms a highly non-isotropic profiles. We have reported that tartaric acid ($C_4H_6O_6$) + hydrogen peroxide (H_2O_2) aqueous solutions are suitable for selective etching of GaAs and fabricating fine structures[1]. In this study, the etching mechanism of GaAs in $C_4H_6O_6$ + H_2O_2 aqueous solutions is reported, and a spectrometric monitoring method for the concentration of hydrogen peroxide in tartaric acid is proposed to control the etching rate of GaAs.

Experimental

The undoped GaAs (100) wafers employed for the experiment were cut into rectangular specimens (30 mm x 50 mm). The mirror-finishing surface of the specimens was covered with a square-patterned photoresistant film. The etching solutions were prepared by mixing 50 wt% tartaric acid ($C_4H_6O_6$) aqueous solution and 30 wt% hydrogen peroxide (H_2O_2) aqueous solution. The chemical etching rate was obtained by measuring the different levels between the covered area (top) and the etched area (bottom) with a surface profilometer (Alpha step). UV spectra were measured with a UV-VIS-NIR spectrometer (JASCO V-570), that detects wavelengthes between 190 nm and 2500 nm.

Results and Discussion

Figure 1 shows the effect of $C_4H_6O_6$ concentration in etching solutions on the etching rate of GaAs. In this case, the concentration of H_2O_2 was kept constant at 0.5 wt%. The etching rate increased sharply with the addition of $C_4H_6O_6$, and the rate was almost constant at about 1 nm s^{-1} above a 5 - wt% concentration of $C_4H_6O_6$. Figure 2 shows the effect of the H_2O_2 concentration in etching solutions on the etching rate of GaAs. The $C_4H_6O_6$ concentration was kept at 50 wt%. GaAs is not chemically etched in 50 wt% $C_4H_6O_6$ aqueous solution without H_2O_2. The etching rate increases linearly with increased H_2O_2 concentration. This shows that $C_4H_6O_6$ does not react with GaAs directly and apparently dissolves oxidation products such as Ga_2O_3 and AsO, formed by the H_2O_2 into the etching solution. In the $C_4H_6O_6$ and H_2O_2 mixed solution, the successive oxidation and dissolution of GaAs is performed during chemical etching. Figure 3 shows the relation between the concentration of H_2O_2 in the etching solution and the absorbance of UV light, observed at 280 nm and 290 nm. The $C_4H_6O_6$ concentration is kept at 50 wt%. The absorbance spectra observed below 250 nm were not influenced by the concentration of H_2O_2. The absorbance observed between 250 nm and 320 nm increases as the H_2O_2 concentration grows, absorbance observed at 280 nm is the most sensitive to changes of H_2O_2 concentration. Figure 4 shows the relation between the absorbance of UV light, observed at 280 nm, and the etching rate of undoped GaAs in the etching solution with different concentration of H_2O_2. The etching rate of GaAs in the etching solution is proportional to the absorbance. This shows that the etching rate of undoped GaAs in a $C_4H_6O_6$ - H_2O_2 aqueous solution system is monitored by the observation of UV absorbance spectra and controlled by the addition of H_2O_2 into the solution.

Reference

1) K. Shigyo, and Z. Kawazu, *Electrochem. Soc. Proceeding*, **PV2000-18**, 23 (2000)

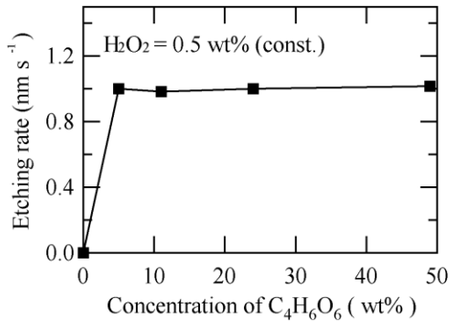

Fig.1 Effect of $C_4H_6O_6$ concentration on etching rate of undoped GaAs in $C_4H_6O_6$-H_2O_2 aqueous solution systems.

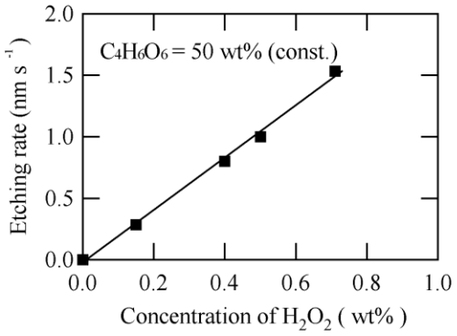

Fig.2 Effect of H_2O_2 concentration on etching rate of undoped GaAs in $C_4H_6O_6$-H_2O_2 aqueous solution systems.

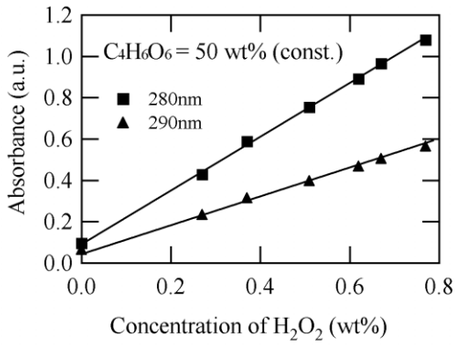

Fig.3 Relation between concentration of H_2O_2 in etching solution and absorbance of UV light observed at 280 nm and 290 nm.

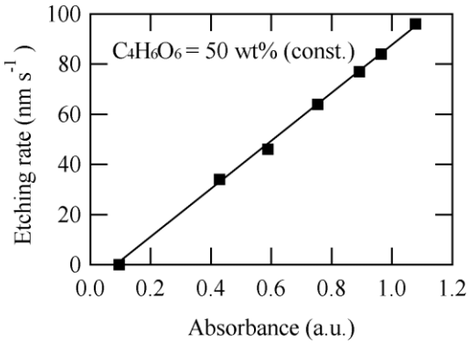

Fig.4 Relation between absorbance of UV light observed at 280 nm and etching rate of undoped GaAs